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IV.—A PHYSIOLOGICAL CRITICISM OF THE LIQUID AND NASAL SONANT THEORY.

Philological investigations into the phonology of the Indo-European languages had at an early time connected certain combinations of liquids and nasals with vowels of different color in the various dialects. The historical explanation, the 'Grundform,' of these differentiated equivalents was given by Professor Brugmann in his often-quoted article on 'Nasalis sonans' in Curtius' Stud., vol. 9, p. 287, in which Brugmann tried to show that under certain conditions the nasal can carry the sonancy of the syllable, i. e. can become a vowel; and that from this sonant the different vowel elements had developed. The history of the investigations that led to Brugmann's theory is so well given by Bechtel in his 'Hauptprobleme der indogermanischen Lautlehre' (p. 114 and ff.), that I refrain from recapitulating what can be conveniently found there.

Brugmann's view was pretty generally accepted for many reasons, the most potent of which was unquestionably its alluring simplicity. Of course, nobody has denied the historical relation of the *a*, α, *en*, *un*, *im*, in *šatám*, ἑκατόν, *centum*, *hund*, *szim̃tas*: it was the perfect equalization of these liquid and nasal diphthongs with the *ei*, *eu*-diphthongs that has called forth occasional criticism. Bechtel and Joh. Schmidt have recently taken up this important question again, the former in his before-mentioned book, the latter in his exhaustive special treatise 'Kritik der Sonantentheorie, eine sprachwissenschaftliche Untersuchung' (Weimar, 1895). Brugmann's reply in his review (Literarisches Centralblatt, 1895, p. 1723 ff.) implies the open confession that the historical evidence is inadequate to solve the question beyond controversy; he even yields the point to Joh. Schmidt by saying: "man kann, auch wenn man sich durch S.'s Beweisfuehrung ganz und gar nicht ueberzeugt fuehlt, ihm doch ein Stueck Weges entgegenkommen, man muss es sogar vielleicht. Formen wie **tᵉntós* und **tn̥tós*, **gᵉrús* und **gr̥rús* sind in Wirklichkeit nicht in dem Masse verschieden, wie es auf dem Papier erscheinen kann. Alle Articulationen haben in Folge der vom Sinn der

Rede und von Stimmung abhaengigen Verschiedenheiten des Sprechtempos u. dergl. stets einen gewissen Spielraum. Namentlich gilt das fuer die Ueberfuehrung der Sprechwerkzeuge aus der festen Stellung fuer einen Laut in die feste Stellung fuer einen andern. So ist es sehr gut moeglich, dass in uridg. Zeit _ᵉn_, _ᵉr_ und _n̥_, _r̥_ und allerlei Zwischenstufen zwischen diesen neben einander gesprochen wurden, wozu es deutliche Parallelen in den modernen Dialecten giebt. Man koennte summarisch z. B. *_tᵉntós_, *_gᵉrús_ als die Formen des langsamen Tempos (Lentoformen), *_tn̥tós_, *_gr̥rús_ als die der lebhafteren Rede (Allegroformen) bezeichnen. Auch mag sein, dass je nach der Natur der umgebenden Consonanten ein 'ᵉ' sich bald leichter, bald weniger leicht einstellte. Das sind aber Dinge, die nicht mehr zu controlieren sind, und fuer die graphische Darstellung der idg. Grundformen, bei der begreiflicher Weise auf solche Finessen fuer gewoehnlich keine Ruecksicht genommen werden kann, empfiehlt sich _n̥_, _r̥_ mehr als _ᵉn_, _ᵉr_." The two possibilities that constitute the point of contention in these recent discussions, viz. a complete reduction of the nasal diphthong to a nasal sonant, or a reduction of the accompanying vowel to a 'minimum of sonancy,' had been clearly recognized by the author of the nasal sonant theory. He had, however, decided in favor of the former alternative, basing his physiological explanation on Sievers' remarks that the liquids _l_, _r_, and the nasals _ṅ_, _n_, _m_ may have the function of vowels as well as of consonants (cf. Grundzuege der Phonetik, 4th ed., §104).

Since historical arguments can confessedly not decide between _ᵉn_ and _n̥_, etc., the solution of the problem must necessarily be left to physiological phonetics. Thanks to the improvements in phonetical instruments, we are now in a position to determine the nature of glides and to measure quantities which cannot be estimated acoustically and which may even be lost to perception. No human ear is, for instance, able to distinguish differences in quantities below one-tenth of a second; experimentally we can measure quantities that vary by one-thousandth of a second. A large number of experiments made with Rousselot's apparatus under varied circumstances, and with the assistance of several persons interested, have led the writer to conclusions that establish the correctness of Joh. Schmidt's views.

Before entering on physiological questions I may be allowed to dispose of some preliminary points. They are here stated briefly, as some, if not all, of them have been discussed in articles bearing on this problem. First of all, then, we have to consider the stipulated sonants as reductions—that is, we have to start with forms that show a vowel in the regular grades. Simple as this point may appear, with our present theory of ablaut it is nevertheless important, as it disposes of Brugmann's *n̥ja*, *n̥nein* argument. The *n̥* here is a deliberative interjection, not reduced from any articulate form, and could never, under any kind of accent, develop to an *en*, etc.

Instances of graphic representations of vocalic consonants have to be guarded against as proofs for the theory. To these belong, for example, the cases in Gothic; forms like *bagms*, *taikns*, etc., only prove that the *m*, *n* were not preceded by a vowel that could be defined by a sound of the Gothic written alphabet. Nor do the quotations from modern dialects carry much weight: they belong, as far as they are not acoustical deceptions, to a literary period and find their constant correction through the written form. I refer here especially to Moeller's *sm̥tóm* and *tn̥támm̥* (for *symptom*, *tentamen*) in Z. f. d. Ph., vol. 25, p. 372; the two cases are, besides, not commensurable.

Nasal sonants do exist, but have never been proven to appear in root syllables. They occur in suffixes, where they cannot interfere with the sense conveyed by the word. Illustrations are very numerous in all languages: the English material is treated by A. M. Bell in his 'Note on Syllabic Consonants,' read before the Mod. Lang. Association, Dec. 1894. In German, to quote only one illustration, we distinguish between the nom. and acc. of *ein Mann* by means of the nasal sonant for the accusative, viz. 'ich habe einn̥ Mann gesehen.' I call attention here to the fact that the *n̥* stands after a nasal of its own kind, just as in the often-quoted *besonn̥nn̥* for *besonnenen*.

Let us now examine the physiological problem. One would suppose that the phonetical values of the sounds that are supposed to have the function of vowels had been carefully established. This is by no means the case, and even scientific grammars have but recently begun to separate the nasals from the liquids. Physiologically the two categories are too different to be compared. Of the nasals *m* and *n* differ by a greater degree of nasality, by the different number of harmonics, and by their closures. What holds good in the case of the *m* need not necessarily apply also to *n*. Still greater is the difference between *l* and *r*. The latter is really a fricative vowel, the quality of which varies according to the place of vibration; the pitch is indistinct, as the fundamental and the harmonics vary constantly on account of the change of the resonant cavity. The *l* has also all the characteristics of a vowel: the size of the lateral opening is here the distinguishing criterion. It readily changes into a vowel; cf. English *talk*, French *aube*<*alba*; the Russian *l* stands on the dividing line. This fundamental difference has hardly ever been taken into account. The mania for mathematical equations at one time threatened to become the ready formula for new discoveries; cf. V. Michels, Zum Wechsel des Nominalgeschlechts im Deutschen, p. 14, and Thurneysen, Das Neutrum im Romanischen, p. 36.

On account of these different articulations all combinations of explosives and nasals, and some combinations of explosives and liquids, are impossible without an intervening vowel (*ə*). I treat here only the cases of explosives plus nasal or liquid.

M. With labial explosives (*bm, pm*) the *ə* must appear after the explosion, else the labial becomes a nasal explosive and falls together with the nasal explosive dental. The labial would then be assimilated to the following nasal; cf. *submitto*>*summitto*, O.H.G. *hraban*, *hram*. The dentals must also be followed by a reduced vowel, or be exploded through the nose and be lost. With gutturals the same development must occur, unless the explosion is protected by an intervening *ə*.

N. Preceded by a labial it may change to a labial nasal, as it always does when followed by a labial: in this case we should have the regular assimilation. If we find it preserved, this is a clear sign that it is protected by the *ə*. Forms like Gothic *bnauan* must not mislead us: if no vowel was pronounced between the *b* and the *n* the O.H.G. *nūan* might go back to this form as well as to the simplex. If *n* follows a guttural in the same syllable, the guttural must be lost, unless a vowel element separates the two sounds. This is a law that, on account of the many instances of the combination, we can prove with absolute certainty. Modern English furnishes the most beautiful illustration of the different steps taken in this development. Towards the end of the seventeenth century the *k, g* before *n* had initially changed their articulation to a nasal explosion, not to be distinguished acoustically from a *t* or *d* with a weak nasal click. About the middle of the following century the gutturals were dropped (cf. the writer's article in Mod. Lang. Notes, 1888, p. 63 ff. and p. 96). Modern

German has a slight tendency in the same direction; cf. g*nade* for *gnade*, etc.; words like *genug*, *Genuss* are protected by the following dark vowel. Latin furnishes another series of examples, whose strict conformity to the just-mentioned law leaves no doubt about the exactness with which the ever ready trap of the nasal sonant responds to the slightest touch. *Navus*, *narus*, *nosco*, *natus* are the only possible resultants of a suppressed reduced vowel: the retention of the guttural in *ignavus*, *ignarus*, *cognosco*, *agnatus* is due to a different syllabication, in spite of the testimony of Terentianus Maurus, Dositheus and others. The instances of *tn*, *dn* can be dismissed without further comment.

L. In connection with labials the fortis will tend to preserve the *ə*; the lenis, pronounced with less force, may allow the tongue to obstruct the air-passage during the *b*-contact. Latin *poplus*—*populus*, *stablum*—*stabulum* are instructive. With dentals the tongue will explode laterally and change the quality of the *t*, *d*, which may be lost; cf. Latin *latus*, *loqui*, suffix *tlo*>*clo*, etc. As to combinations with gutturals, it may be interesting to call attention to Webster's sound notation in his first edition of his Dictionary (1828): "*clear*, *clean* are pronounced *tlear*, *tlean*. *Glory* is pronounced *dlory*."

R. The *r*, whether lingual or uvular, can be pronounced in any consonant combination without an intervening vowel. Of course, only the former concerns us here; the number of vibrations in a second is, in my case, about thirty-three. As two to three vibrations are sufficient to characterize the *r* as such, about one-half of the average quantity of the consonant is usually vocalic. In the rather distinct pronunciation of the *r* in Slavic languages I have found the on and off-glides trilled, the rest is vocalic. If the air-current is not strong enough the vibration will not appear—that is, the indistinct vowel would necessarily occur in unaccented syllables: this physiological fact would be in direct opposition to the whole sonant theory.

The following tables, compiled from a large number of experiments, give the quantities of the indistinct vowel as compared with a clearly pronounced *e* in the same combinations. The values are given in seconds, some in the third decimal; the bracketed numbers express the average quantities of all measurements taken.

Length of vowel element between explosives and nasals.

kn: 0.1; 0.15; 0.12; 0.06; 0.02; 0.03; 0.026; 0.044; [0.0687].
knī: 0.05; 0.05; 0.075; 0.12; 0.075; 0.075; 0.055; 0.08; 0.03; [0.0677].
knū: 0.045; 0.075; 0.065; 0.08; 0.05; [0.063].
km: 0.04; 0.1; 0.045; 0.06; 0.06; 0.05; 0.075; [0.0614].
gn: 0.054.
gnā: 0.085; 0.04; 0.045; 0.06; 0.08; 0.06; 0.03; 0.036; 0.03; 0.03; 0.035; [0.0483].
gnū: 0.085; 0.1; 0.075; 0.06; 0.04; 0.051; 0.09; 0.01; [0.0751].
gm: 0 08; 0.055; 0.06; [0.065].
tn: 0.055; 0.074; 0.052; 0.07; [0.0627].
tm: 0.11; 0.071; [0.0905].
dn: 0.11; 0.07; [0.09].
dm: 0.1; 0.09; [0.095].
tnū: 0.054; 0.042; [0.048].
pn: 0.11; 0.07; 0.03; 0.07; 0.05; [0.066].
pm: 0.06; 0.09; [0.075].
bn: 0.075; 0.09; 0.073; 0.062; [0.075].
bm: 0.075; 0.09; 0.065; [0.0766].

Length of ĕ between explosives and nasals.

kĕn: 0.165; 0.22; 0.19; 0.15; 0.115; 0.133; 0.12; [0.156].
kĕm: 0.145; 0.2; 0.1; 0.15; 0.14; 0.125; 0.155; 0.14; 0.125; [0.142].
gĕn: 0.16; 0.18; 0.14; 0.115; [0.149].
gĕm: 0.17; 0.2 (*ẽ*?); 0.165; 0.15; [0.171].
tĕn: 0.15; 0.17; 0.145; 0.138; 0.139; [0.148].
tĕm: 0.19; 0.26 (*ẽ*?); [0.225].
dĕn: 0.13; 0.22 (*ẽ*?); 0.125; [0.158].
dĕm: 0.145; 0.25 (*ẽ*?); 0.21 (*ẽ*?); [0.202].
pĕn: 0.155; 0.3 (*ẽ*?); 0.13; 0.132; 0.147; [0.173].
pĕm: 0.175; 0.21 (*ẽ*?); 0.155; [0.18].
bĕn: 0.15; 0.21 (*ẽ*?); 0.11; 0.135; [0.151].

These investigations lead us to the following conclusions. The reduction of a syllable consisting of an explosive + short vowel + nasal results in a decrease of the vowel quantity by one-half of its original value approximately. If the vowel is suppressed the initial consonant is lost also. Latin *genu*, German *Knie*, English *knee* are sufficient illustrations; French *canif* and English *knife* are the lento and allegro forms respectively of Low German *Knif.* With this law agree also the forms quoted by Moeller (Z. f. d. Ph. 25, p. 372 ff.) and others in support of the sonant theory. The timbre of the reduced vowel is dependent on the quality of the surrounding consonants, and the basis of articulation. Its quantity is much less subject to the articulation of the consonants preceding and following, but may vary considerably as long as its timbre does not invade the range of the tone color of the *a*, *e*, *i*, etc. The liquids, especially *l*, are more difficult to investigate; as their development in reduced syllables, however, corresponds to that of the nasals, this fact alone is sufficient to invalidate the liquid sonant theory also. Long sonants and stressed sonants, with the possible exception of *r*, must be discarded for the same reason. It is besides hard to imagine that a possible long or accented nasal sonant should develop differently, since the tone quality of the nasal does not change perceptibly; the differentiation could be explained on the basis that the reduced vowel changes its tone color under varied stress, and may fall together with the normal grades. But such questions, as all speculations about the ultimate reason of the vowel development, had better be postponed until our knowledge of the physiology of vowels rests on a generally acceptable foundation, which at present we are far from possessing, in spite of the discoveries of Helmholtz and his disciples.

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